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Hattori et al.

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(54) **BOOKBINDING APPARATUS, BOOKBINDING SYSTEM, AND ADHESIVE COATING METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 683 days.

This patent is subject to a terminal disclaimer.

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B42C 9/00 (2006.01)

(52) **U.S. Cl.** **412/14**; 412/37; 412/33; 156/359; 118/693; 270/58.09

(58) **Field of Classification Search** 118/666, 118/667, 693; 156/351, 359, 578, 908; 270/58.04, 270/58.09; 412/1, 2, 4, 6, 8, 11, 12, 14, 19, 412/33, 37, 41, 902, 908; 700/299
See application file for complete search history.

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(74) *Attorney, Agent, or Firm*—Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.

(57) **ABSTRACT**

A bookbinding apparatus for forming a booklet by coating an adhesive on a spine of a stack of sheets, including: a coating apparatus, which has an adhesive reservoir to store a liquid of the adhesive, and a coating roller to coat on the spine the adhesive scooped up from the adhesive reservoir; a pellet storage section to store pellets of the adhesive; a replenishing section to replenish the pellets of the adhesive into the adhesive reservoir; an adhesive quantity sensor to detect a liquid level in the adhesive reservoir; and a controller to control the replenishing section based on a detection signal of the adhesive quantity sensor, wherein the controller controls a rate of replenishing amount of the pellets by controlling the replenishing section based on information of the stack of sheets.

8 Claims, 8 Drawing Sheets

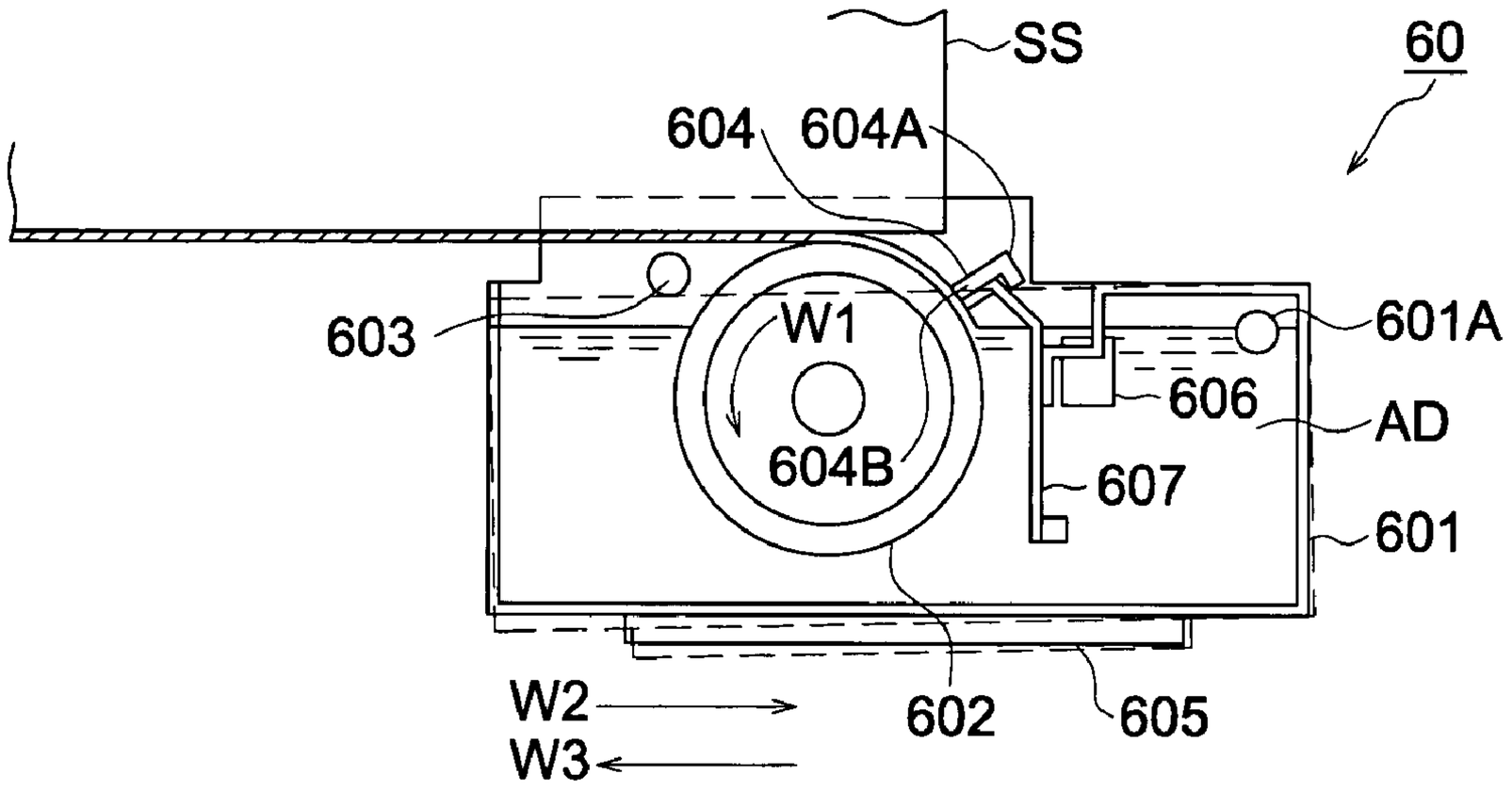


FIG. 1 (a)

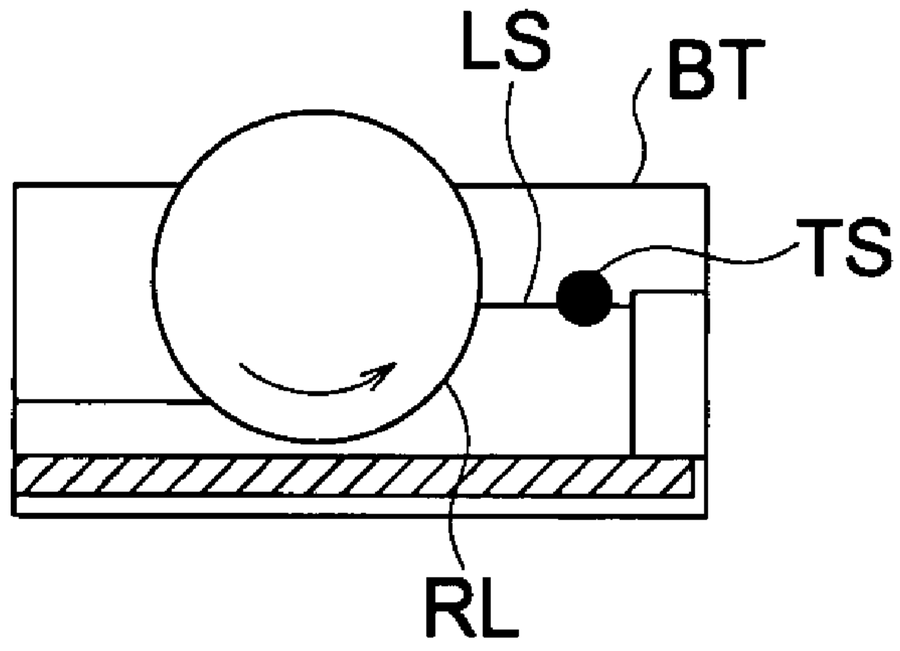


FIG. 1 (b)

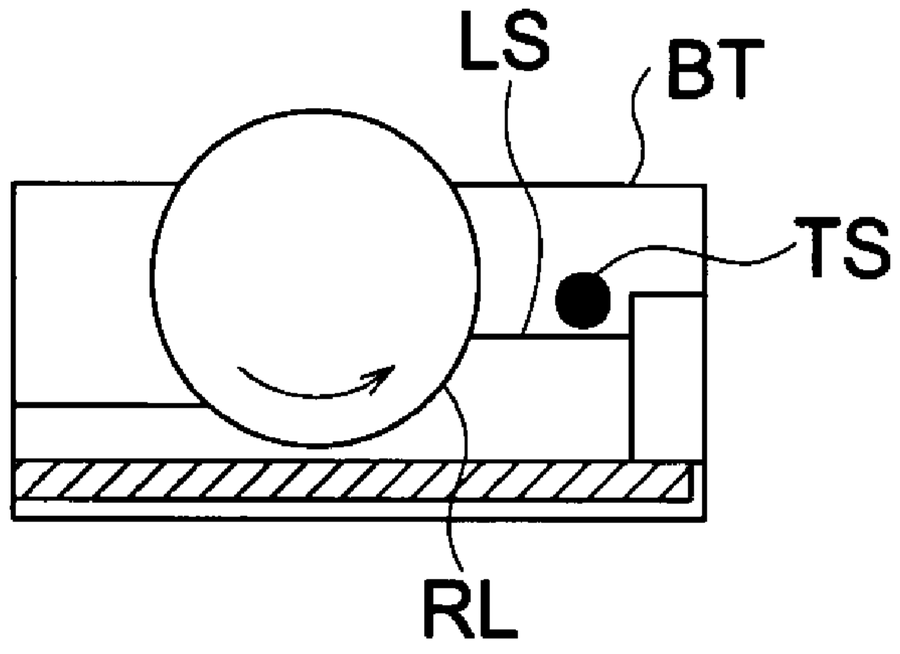
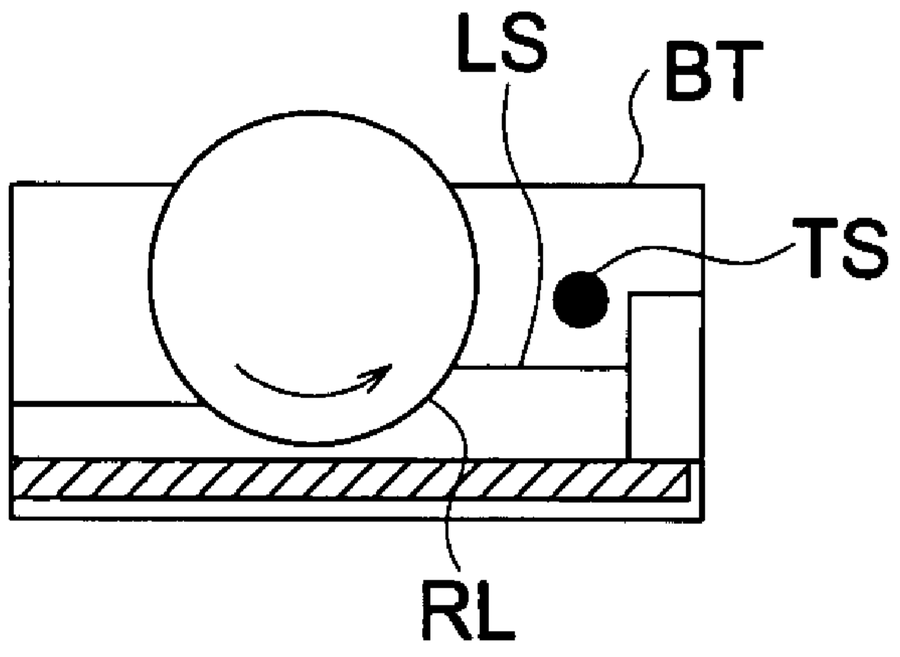


FIG. 1 (c)



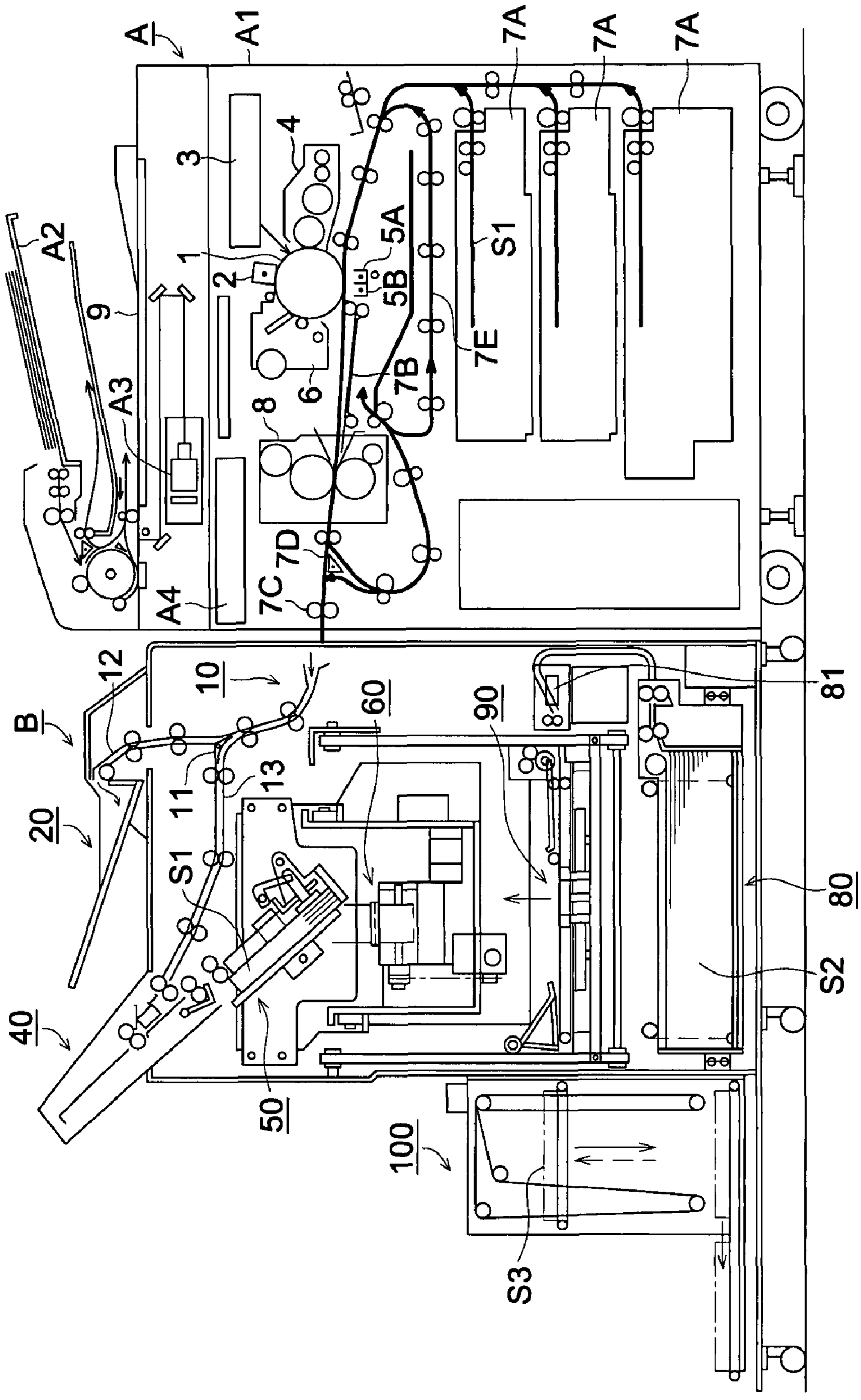

A
A1
7A
7A
7A
4
3
A2
1
2
5A
5B
S1
9
7E
7B
A3
6
8
A4
7C
7D
12
10
60
90
81
B
13
11
20
S1
80
S2
40
50
100
S3

FIG. 2

FIG. 3

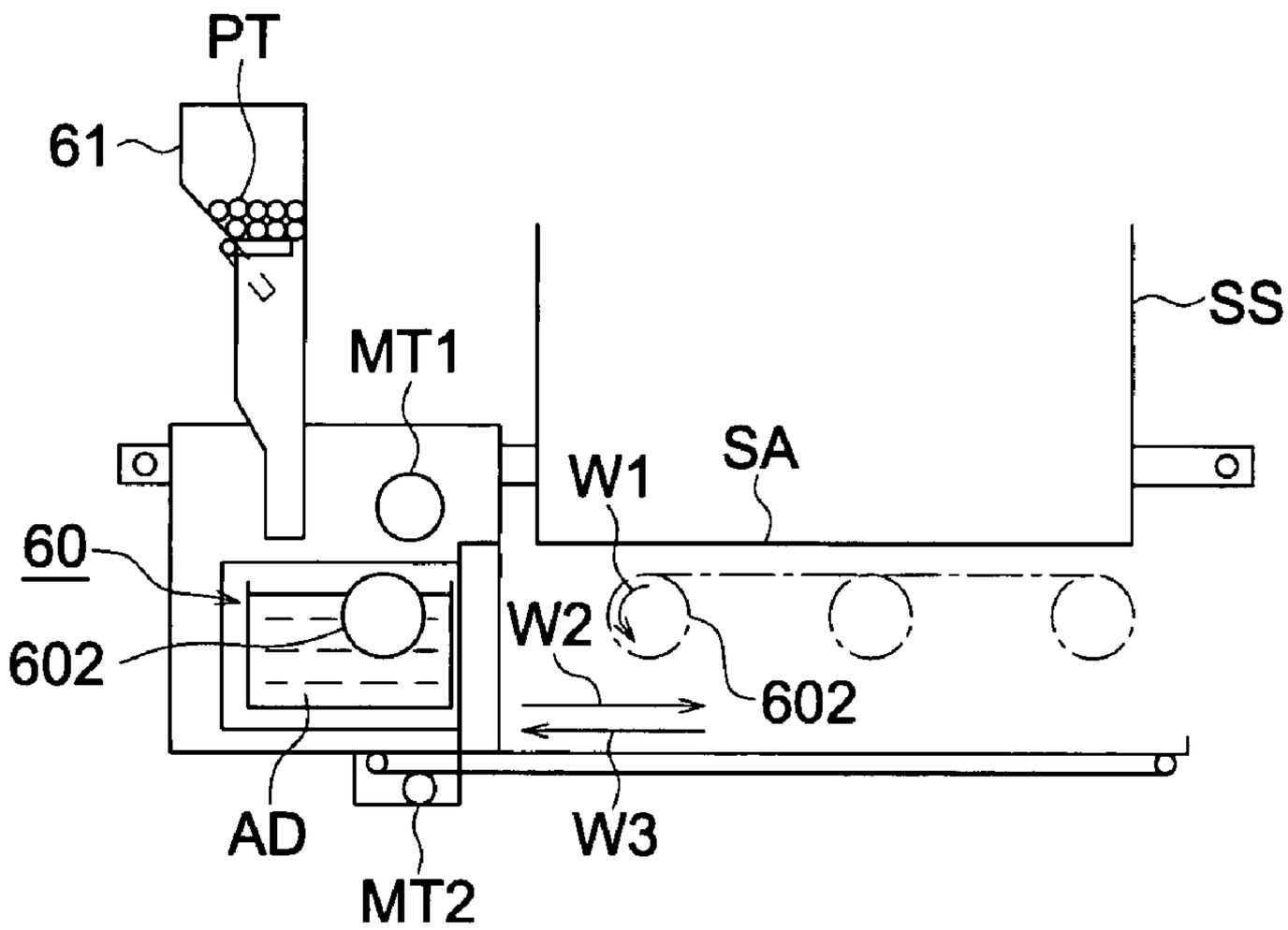

PT
61
MT1
SS
W1
SA
60
602
W2
602
AD
W3
MT2

FIG. 4

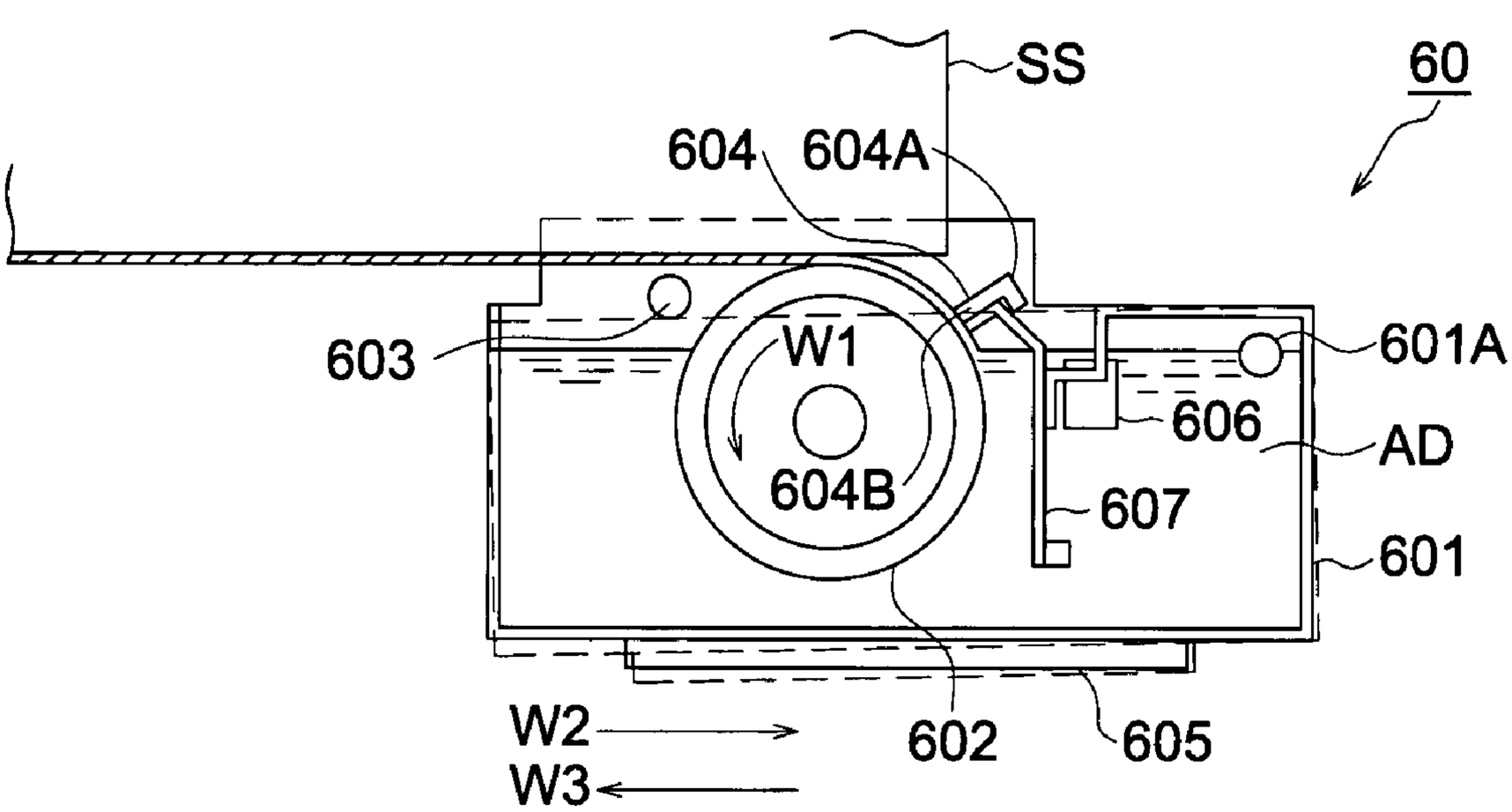

SS
60
604
604A
603
W1
601A
606
AD
604B
607
601
W2
602
605
W3

FIG. 5

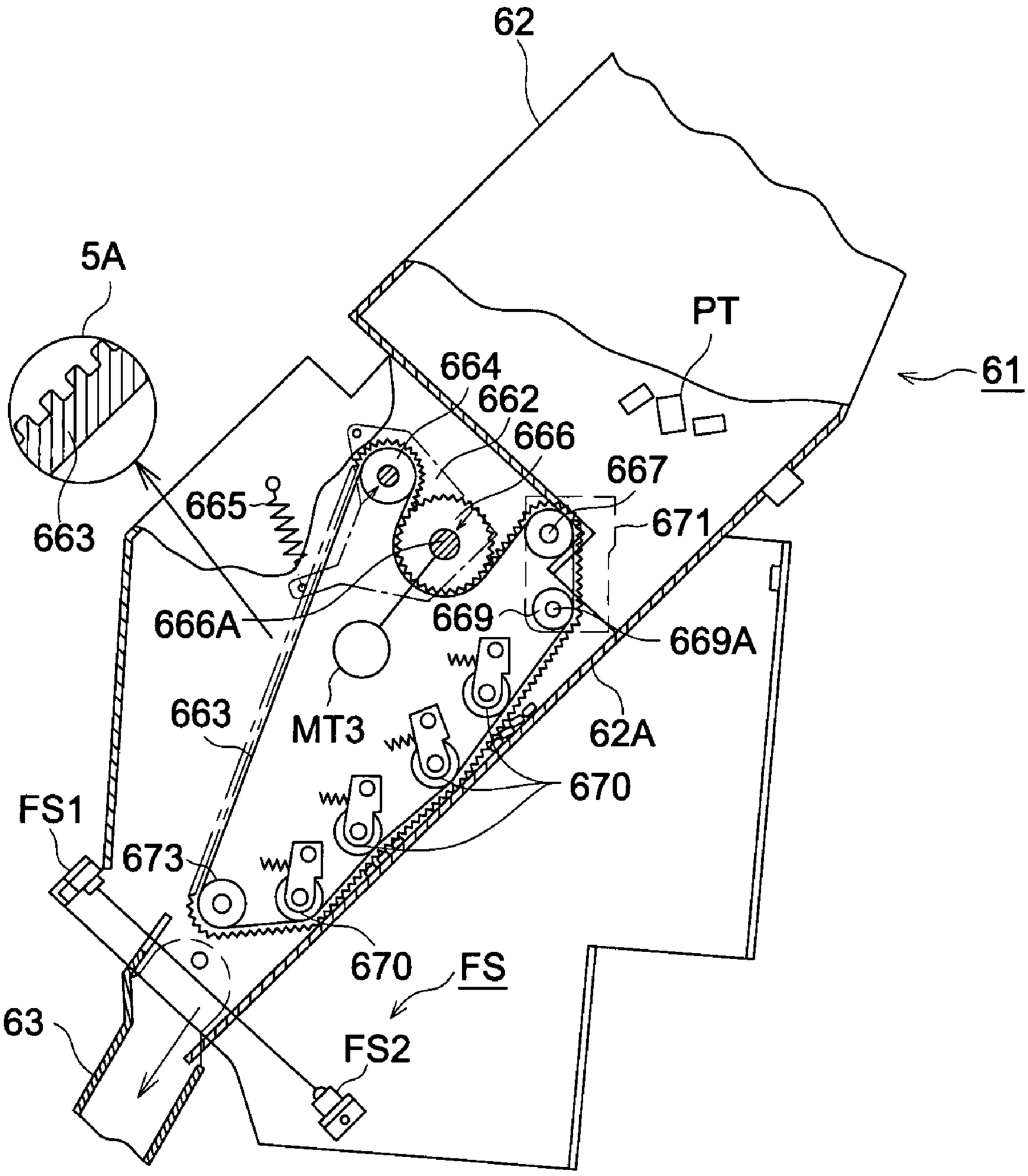

62
5A
PT
61
664
662
666
667
665
671
663
669
669A
666A
MT3
62A
663
670
FS1
673
670
FS
63
FS2

FIG. 6

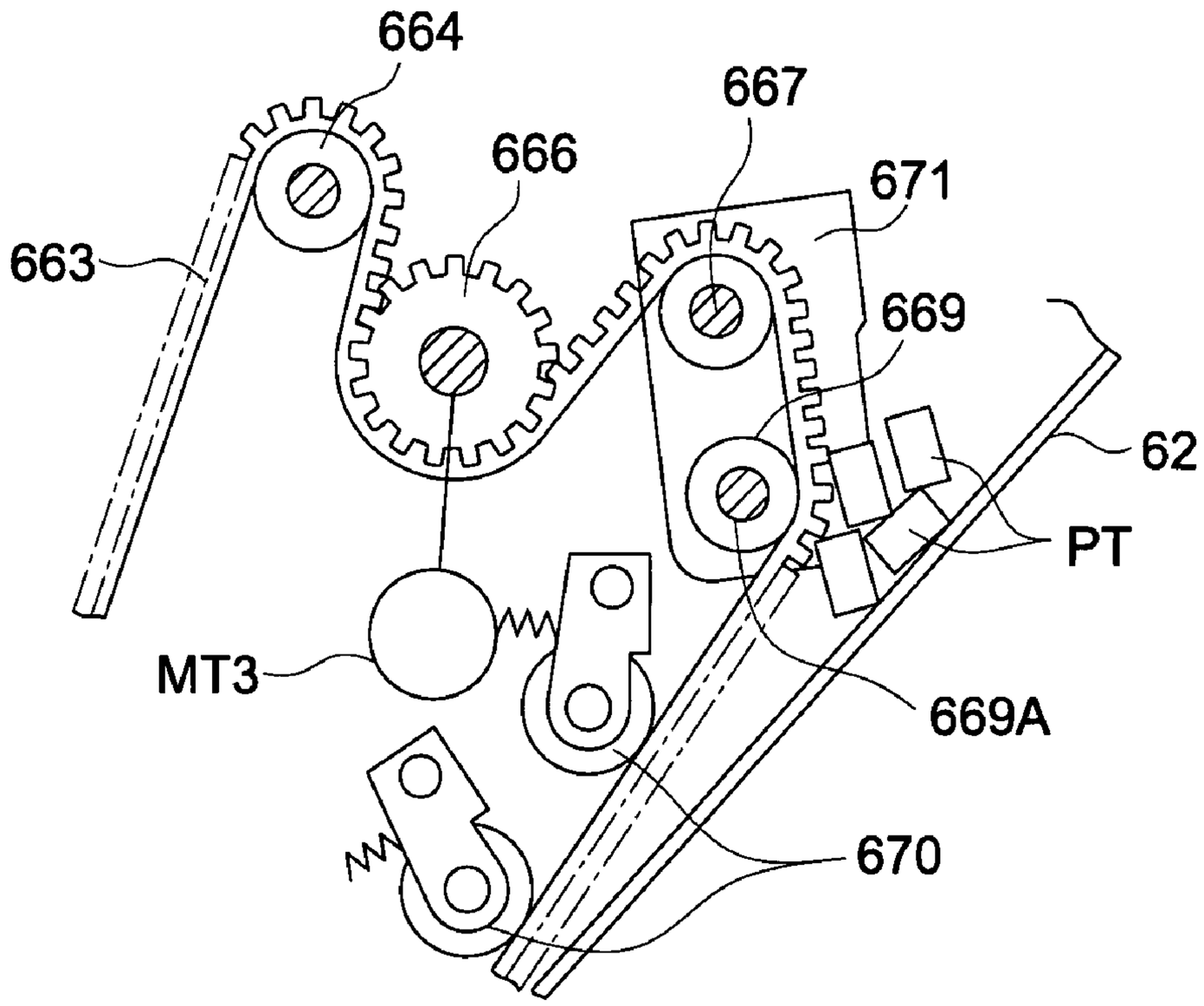

664
667
666
671
663
669
62
PT
MT3
669A
670

FIG. 7

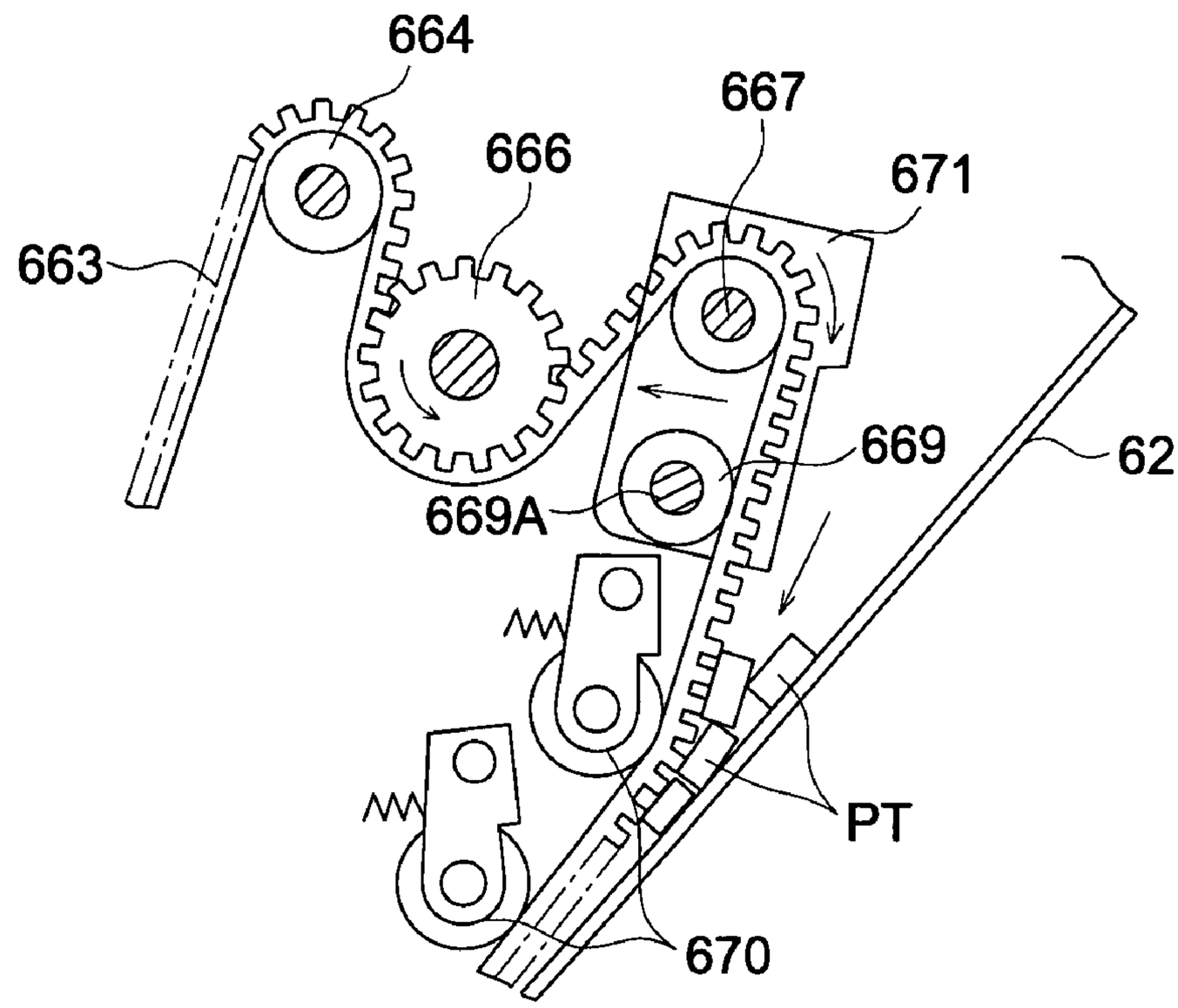

664
667
666
671
663
669
62
669A
PT
670

FIG. 8 (a)

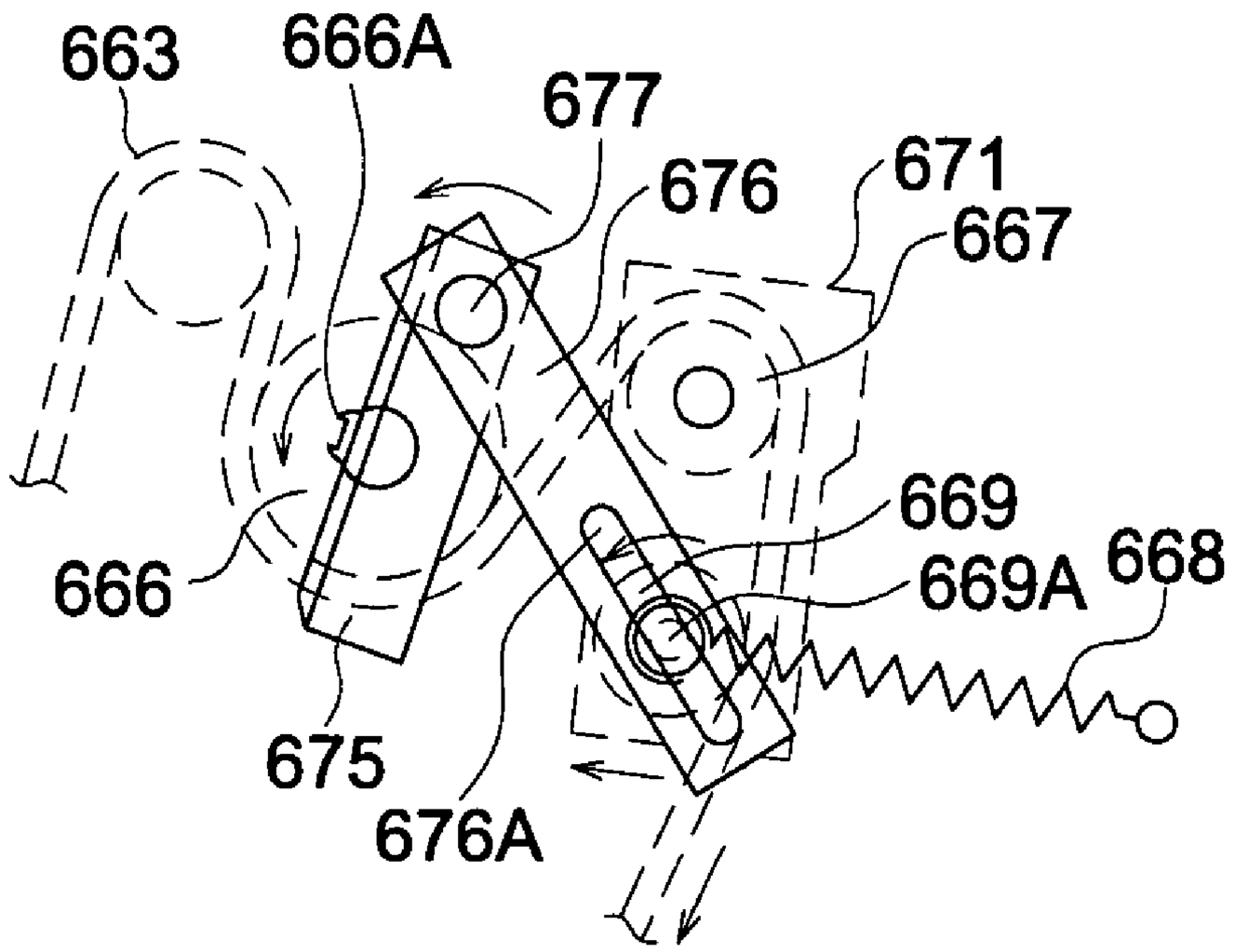

663
666A
677
676
671
667
669
669A
668
666
675
676A

FIG. 8 (b)

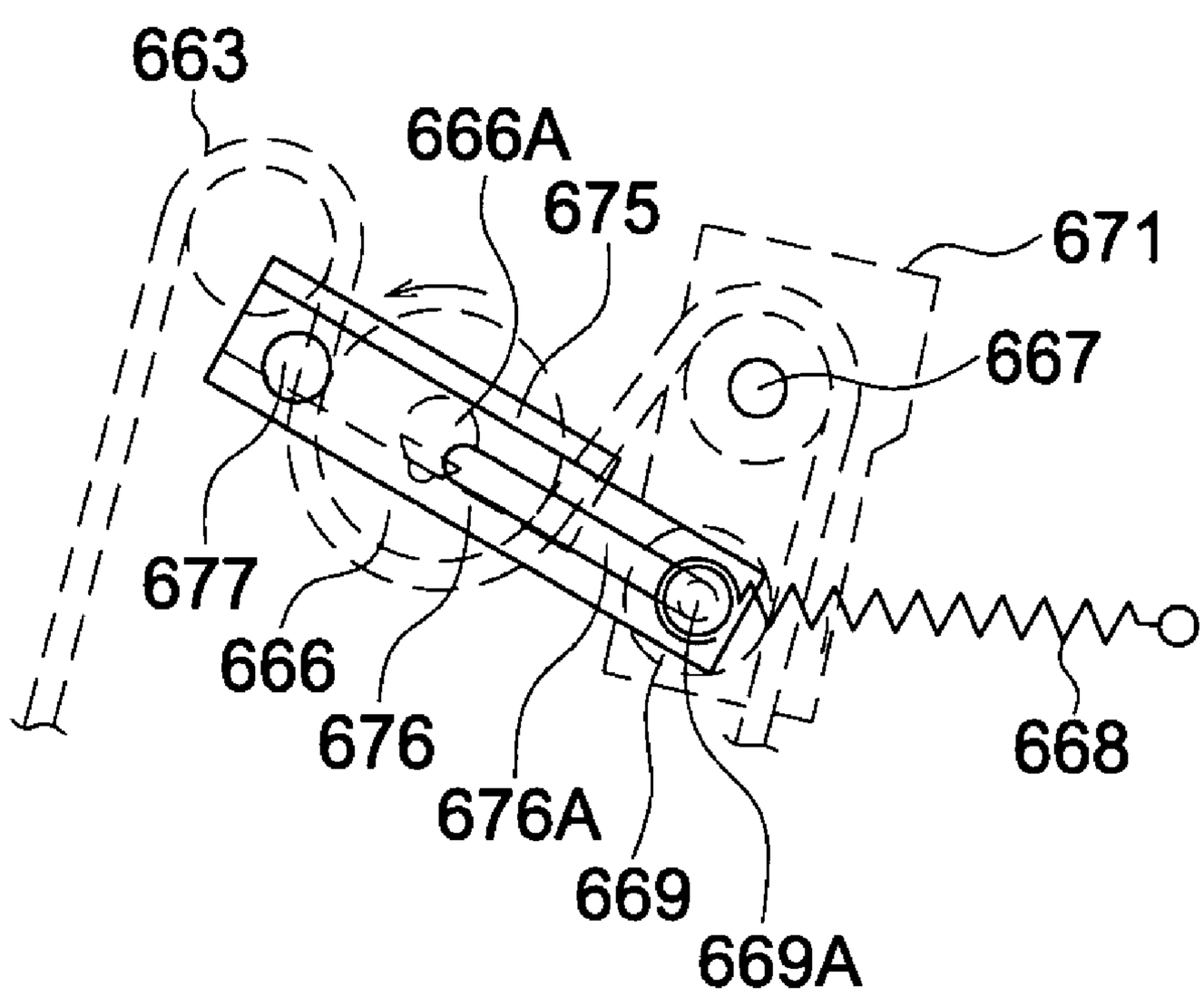

663
666A
675
671
667
677
666
676
676A
669
669A
668

FIG. 9

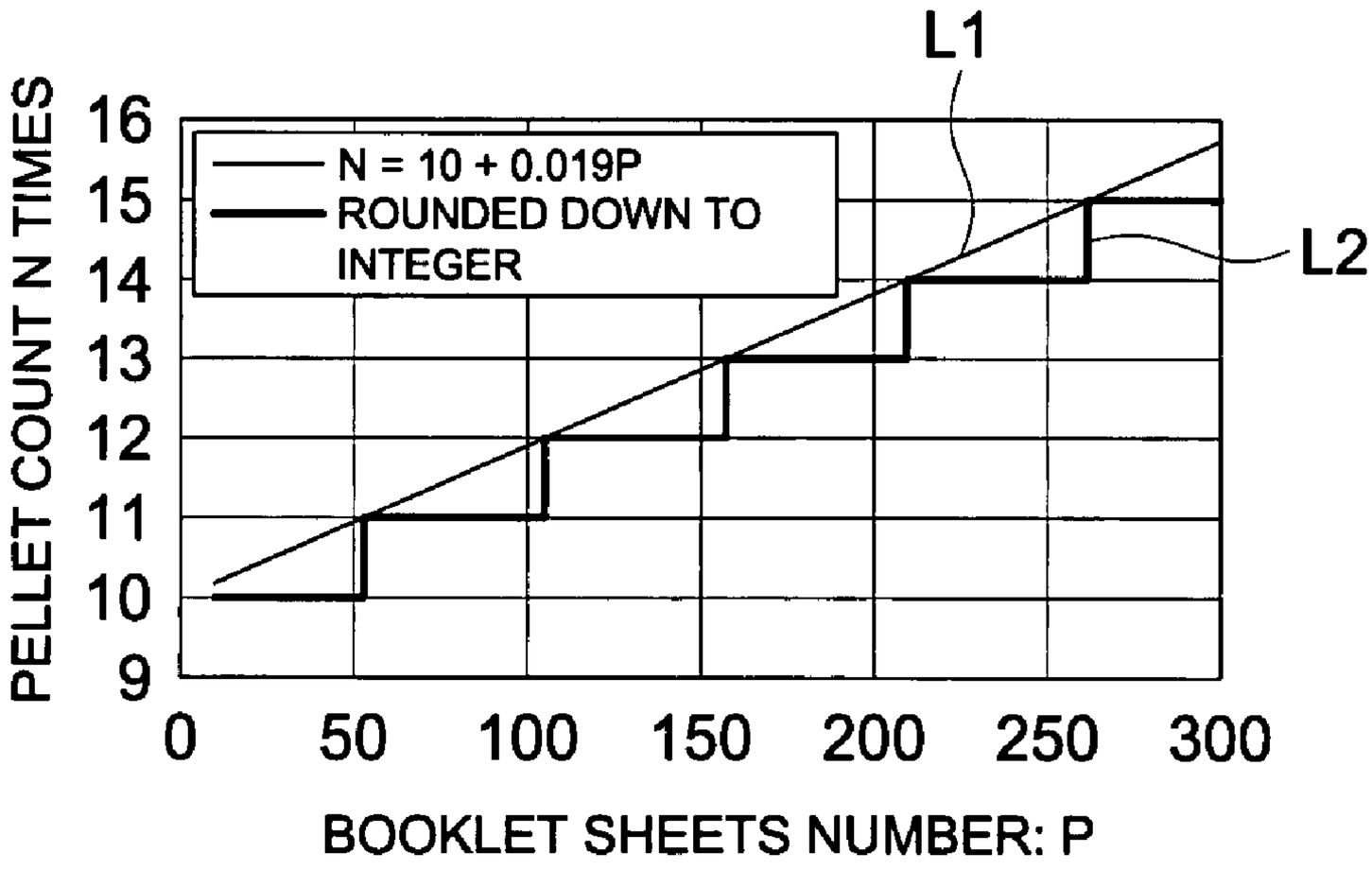

L1
L2
N = 10 + 0.019P
ROUNDED DOWN TO INTEGER
PELLET COUNT N TIMES
16
15
14
13
12
11
10
9
0
50
100
150
200
250
300
BOOKLET SHEETS NUMBER: P

FIG. 10

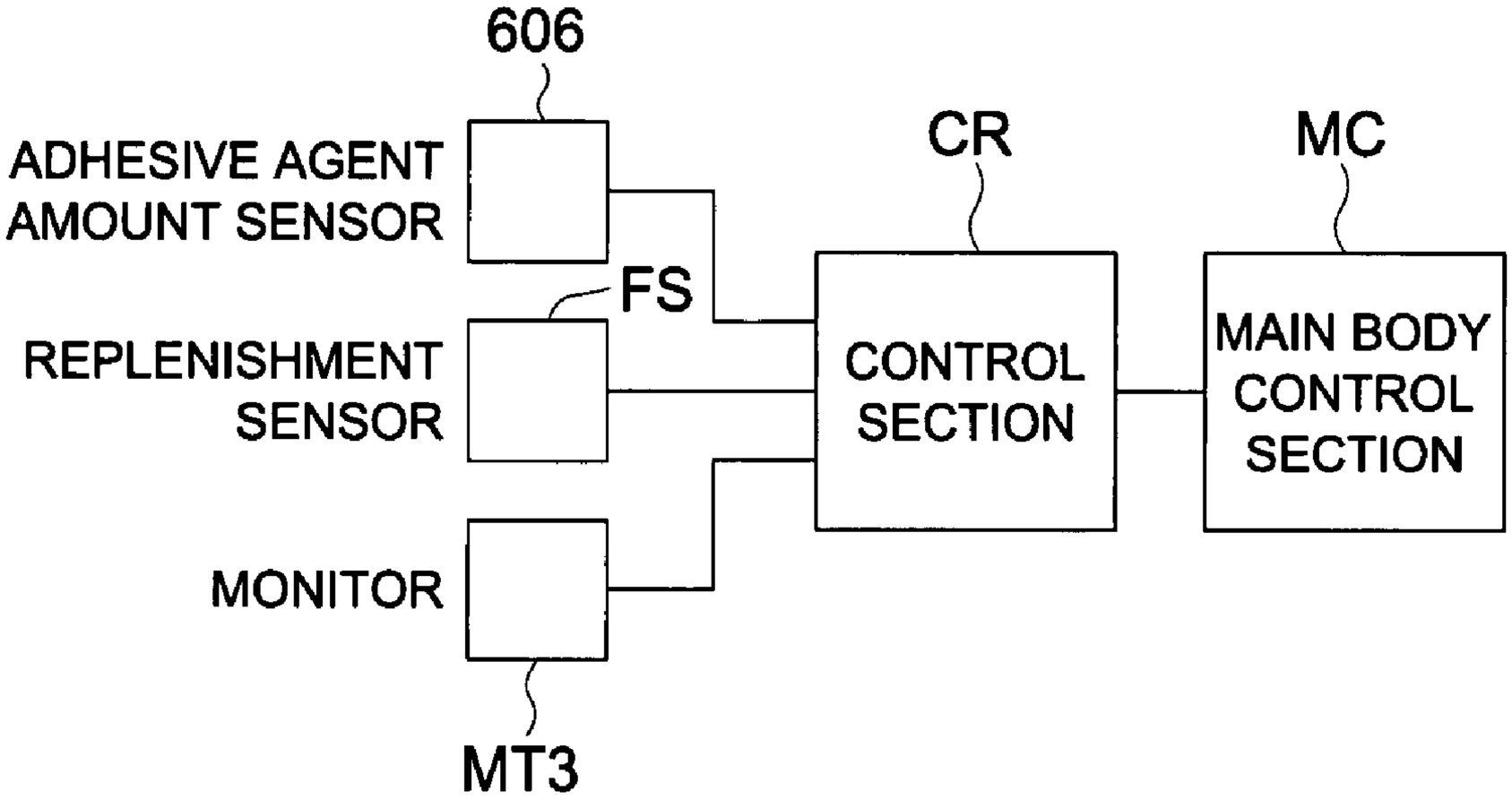
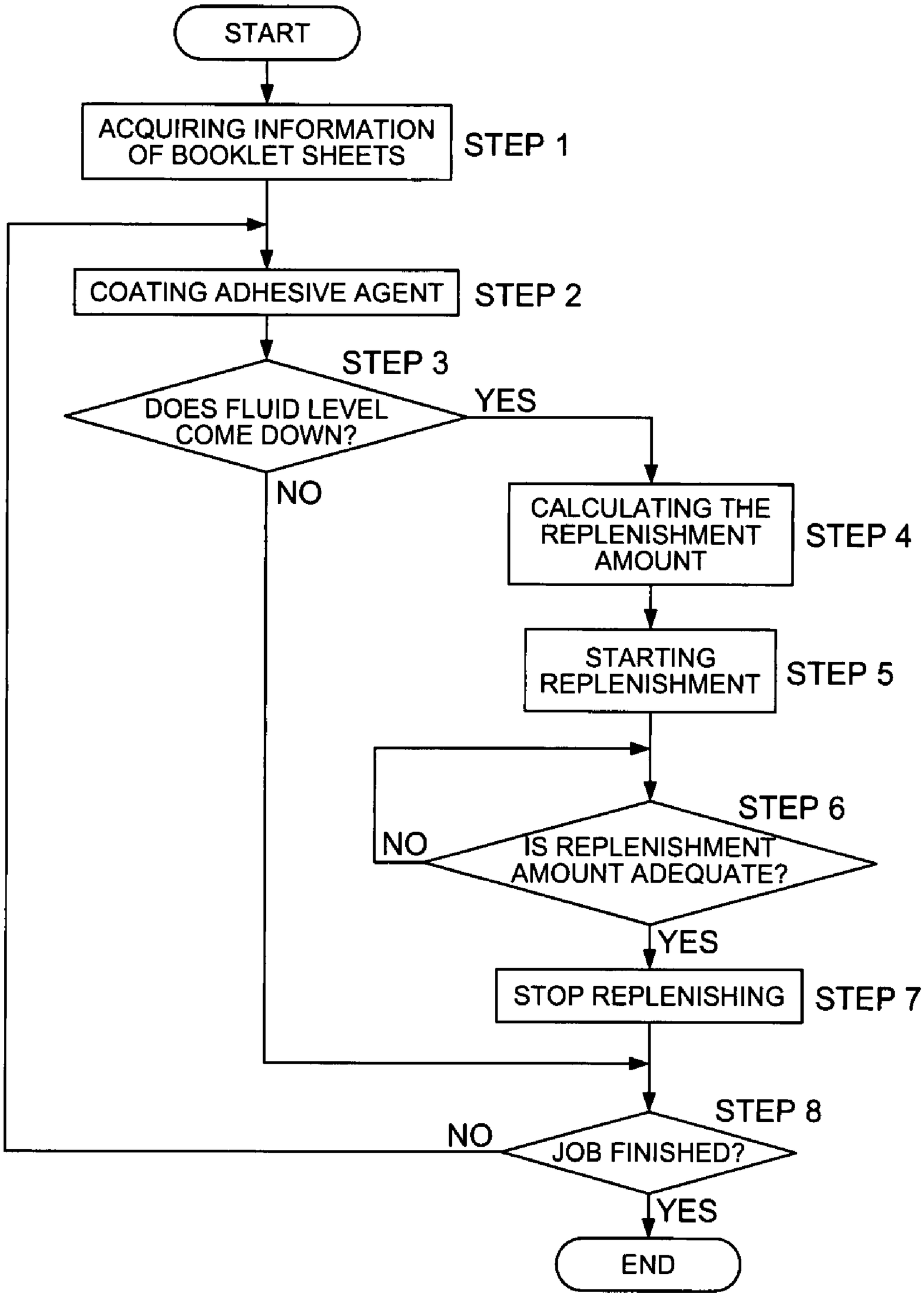

606
ADHESIVE AGENT AMOUNT SENSOR
FS
REPLENISHMENT SENSOR
MONITOR
MT3
CR
CONTROL SECTION
MC
MAIN BODY CONTROL SECTION

FIG. 11


START
ACQUIRING INFORMATION OF BOOKLET SHEETS
STEP 1
COATING ADHESIVE AGENT
STEP 2
STEP 3
DOES FLUID LEVEL COME DOWN?
YES
NO
CALCULATING THE REPLENISHMENT AMOUNT
STEP 4
STARTING REPLENISHMENT
STEP 5
STEP 6
IS REPLENISHMENT AMOUNT ADEQUATE?
NO
YES
STOP REPLENISHING
STEP 7
STEP 8
JOB FINISHED?
NO
YES
END

BOOKBINDING APPARATUS, BOOKBINDING SYSTEM, AND ADHESIVE COATING METHOD

CROSS REFERENCE TO RELATED APPLICATION

The present application is based on Japanese Patent Application No. 2006-233321 filed with Japan Patent Office on Aug. 30, 2006, the entire content of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

The present invention relates to bookbinding apparatuses, bookbinding systems, and adhesive coating methods that form booklets by coating an adhesive on the edge (spine) of a plurality of sheets that have been stacked, and, in particular, to bookbinding apparatuses, bookbinding systems, and adhesive coating methods that carry out adhesive coating operation for each individual booklet.

2. Description of Related Art

Bookbinding apparatuses that coat the adhesive for each booklet and bind the sheets are used frequently in bookbinding systems that carry out in one sequence the operations from image formation up to bookbinding. In such bookbinding apparatuses, hot melt type adhesives are used, and the binding operation is carried out continuously by replenishing small quantities of the pellets of the adhesive according to the consumption due to coating. In Patent Documents 1 and Patent Document 2, a replenishing apparatus has been disclosed in which the adhesive is coated on the stack of sheets by moving the coating roller along the spine of the stack of sheets, and pellets of adhesive are replenished at a constant rate in units of a few pellets to the molten adhesive reservoir in which the coating roller is dipped.

Patent Document 1: Unexamined Japanese Patent Application Publication No. 2004-209746.

Patent Document 2: Unexamined Japanese Patent Application Publication No. 2004-276457.

In a coating apparatus that coats the adhesive by moving the coating apparatus constituted to have a coating roller and an adhesive reservoir along the spine of the stack of sheets, since there is a restriction on the volume of the coating apparatus, even the volume of the adhesive reservoir will be restricted.

Because of this, the extent of lowering of the liquid level in the adhesive reservoir becomes large due to the reduction in the quantity of liquid that is consumed by coating, and in order to make the coating uniform, a means is required to suppress the up and down displacement of the liquid level.

In Patent Document 1 and Patent Document 2, a constant quantity of pellets is being supplied when the quantity of adhesive in the adhesive reservoir becomes small, and because of this, the adhesive liquid level is maintained constant. However, according to the adhesive replenishment method of Patent Document 1 and Patent Document 2, there will be up and down displacement of the adhesive liquid level, and it is difficult to carry out uniform coating. This is because of the following reasons.

This is explained below using FIGS. **1**(*a*) to **1**(*c*).

The liquid level LS of the molten adhesive is detected using an adhesive quantity sensor TS that detects the temperature, and, as is shown in FIG. **1**(*a*) to FIG. **1**(*b*) or FIG. **1**(*c*), when the adhesive quantity sensor TS gets separated from the liquid level LS due to lowering of the liquid level LS, the temperature detected by the adhesive quantity sensor TS falls, and hence a lowering of the liquid level LS is detected.

When the volume of the adhesive reservoir BT is small, since the ratio of the quantity of adhesive scooped up by the coating roller RL to the quantity of adhesive in the adhesive reservoir is high, the fluctuations in the position of the liquid level is large, and when the thicknesses of the stack of sheets to be coated are different, there will be cases in which the state changes from that of FIG. **1**(*a*) to FIG. **1**(*b*) and from that of FIG. **1**(*a*) to FIG. **1**(*c*) due to one coating process.

Further, as is shown in the FIG., when the coating roller rotates as shown by the arrow mark, although the liquid level LS of the adhesive becomes high on the downstream side of the direction of rotation of the coating roller RL due to the viscosity of the liquid, the level of the liquid level LS on the downstream side is rather stable, and by detecting on the downstream side, it is possible to detect he quantity of adhesive in the adhesive reservoir accurately.

The adhesive quantity sensor TS cannot distinguish between the conditions of FIG. **1**(*b*) and FIG. **1**(*c*) by merely detecting that the state has changed from FIG. **1**(*a*) to FIG. **1**(*b*) and from FIG. **1**(*a*) to FIG. **1**(*c*). In other words, the adhesive quantity sensor TS carries out only ON/OFF detection, and cannot detect the amount of reduction in the level of the liquid level.

Therefore, when replenishment of adhesive is carried out using the detection signal from an adhesive quantity sensor such as in FIG. **1**(*a*) to FIG. **1**(*c*), due to the difference in the rate of consumption of the adhesive, the liquid level of the adhesive moves up and down, and it becomes difficult to carry out uniform coating.

If a plurality of adhesive quantity sensors is used, although it is possible to detect multiple levels of the liquid level, there are problems in terms of cost and the space for installing the adhesive quantity sensors, and the problem becomes more pronounced when increasing the accuracy of detection.

The present invention is intended to solve this kind of problems in replenishing adhesive to the coating apparatus, and the purpose of the present invention is to provide a bookbinding apparatus that makes it possible to coat uniformly using a coating apparatus that has been made small in size.

SUMMARY OF THE INVENTION

A configuration reflecting one aspect of the present invention is a bookbinding apparatus for forming a booklet by coating an adhesive on a spine of a stack of sheets, the bookbinding apparatus comprising: a coating apparatus, which includes, an adhesive reservoir to store a liquid of the adhesive, and a coating roller to coat on the spine of the stack of sheets the adhesive scooped up from the adhesive reservoir; a pellet storage section to store pellets of the adhesive; a replenishing section to replenish the pellets of the adhesive from the pellet storage section into the adhesive reservoir; an adhesive quantity sensor to detect a liquid level in the adhesive reservoir; and a controller to control the replenishing section based on a detection signal of the adhesive quantity sensor, wherein the controller controls a rate of replenishing amount of the pellets by controlling the replenishing section based on information of the stack of sheets.

A system reflecting another aspect of the present invention is a bookbinding system comprising: an image forming apparatus for forming images on sheets; and the bookbinding apparatus described above, wherein the bookbinding apparatus receives the sheet from the image forming apparatus and forms the booklet.

A method reflecting another aspect of the present invention is an adhesive coating method for coating an adhesive on a spine of a stack of sheets by moving relatively a coating apparatus and the stack of sheets along the spine of the stack of sheets, the coating apparatus having an adhesive reservoir to store a liquid of the adhesive and a coating roller to coat the adhesive scooped up from an adhesive reservoir, the adhesive coating method comprising the steps of: detecting a liquid level of the adhesive in the adhesive reservoir by an adhesive quantity sensor; activating a replenishing section to replenish pellets of the adhesive from a pellet storage section into the adhesive reservoir, when lowering of the liquid level is detected by the adhesive quantity sensor, wherein a rate of replenishing amount of the pellets is made changeable.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, advantages and features of the invention will become apparent from the following description thereof taken in conjunction with the accompanying drawings in which:

FIGS. **1**(*a*) to **1**(*c*) are diagrams showing the detection of the adhesive quantity by the liquid level fall sensor;

FIG. **2** is a diagram showing an entire image forming system provided with a bookbinding apparatus according to a preferred embodiment of the present invention;

FIG. **3** is a diagram showing the coating process;

FIG. **4** is a diagram showing the configuration of the coating device **60**;

FIG. **5** is a cross-sectional view diagram of the replenishing device **61**;

FIG. **6** is a diagram showing the important parts of the replenishing device **61** before the operations are started;

FIG. **7** is a diagram showing the important parts of the replenishing device **61** during replenishment;

FIGS. **8**(*a*) and **8**(*b*) are diagrams showing the drive system in the replenishing device **61**;

FIG. **9** is a diagram showing the rate of replenishment for carrying out appropriate adhesion for the number of sheets S**1** constituting the sheet stack SS;

FIG. **10** is a block diagram of the control system carrying out control of the adhesive replenishment; and

FIG. **11** is a flow chart of coating control.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Although the present invention is described here using a preferred embodiment shown in the figures, the present invention shall not be limited to the preferred embodiment.

FIG. **2** is a diagram showing an entire image forming system provided with a bookbinding apparatus according to a preferred embodiment of the present invention.

The image forming system has an image forming apparatus A and a bookbinding apparatus B.

The image forming apparatus A is one that forms images on sheets using the electro-photography method, and has an image forming section A**1**, a document feeding device A**2**, and an image reading section A**3**.

In the image forming section A**1** arranged are a charging unit **2**, an exposure unit **3**, a developing unit **4**, a transfer unit **5**A, a separation unit **5**B, and a cleaning unit **6** on the periphery of a drum shaped photoreceptor **1**, and using these electro-photographic process devices, a toner image is formed on the photoreceptor **1** and the image is formed on the sheet S**1** after charging, exposure, developing, and transfer are carried out.

The sheets S**1** are stored in three sheet feeding trays **7**A, and one sheet at a time of the sheet S**1** is fed from these sheet feeding trays **7**A, and the toner image on the photoreceptor **1** is transferred on to the sheet S**1** by the transfer unit **5**A.

The toner image transferred onto the sheet S**1** is fixed by passing through the fixing unit **8**. The fixed sheet S**1** either is discharged by the ejection roller **7**C or is conveyed to the re-feeding path **7**E.

According to face-down sheet discharge in single-sided printing, face-up sheet discharge in single-sided printing, or front surface image formation in double-sided image formation, the switching gate **7**D switches and guides the sheet S**1**. In other words, during face-up sheet discharge, the switching gate **7**D causes the sheet S**1** to proceed forward, and in face-down sheet discharge or in double-sided image formation, the switching gate **7**D guides the sheet S**1** downwards.

In face-down sheet discharge, the sheet S**1**, after being guided downwards, is switched back and is conveyed in the upward direction, and is then discharged by the ejection roller **7**C.

In double-sided image formation, the sheet S**1** is guided downwards, after being turned upside down by switching back, it passes through the sheet feeding path **7**E, fed to the transfer section in which is placed the transfer unit **5**A, and the image of the back surface is transferred onto it.

The document feeding device A**2** conveys the document one sheet at a time to the reading position. The image reading section A**3** reads out the image of the document conveyed by the document feeding device A**2** or the image of the document placed on the document table **9**, and generates the image signals.

The bookbinding apparatus B is an apparatus that stacks a plurality of sheets that constitute a book and that are fed from the image forming apparatus A, and configures a stack of sheets to be formed into a book, joins a cover sheet to that stack of sheets, and prepares a book. In the following explanations, the sheets constituting a book are called sheets S**1**, and the cover sheet is called a cover S**2**, and the sheets constituting a book to which a cover sheet has been joined is called a booklet S**3**.

The bookbinding apparatus B has a conveying section **10** that conveys the sheets S**1** discharged from the image forming apparatus A either to an ejection tray **20** or to a sheet reversing section **40**, an ejection tray **20**, a sheet reversing section **40**, a stacking section **50** that stacks the sheets S**1** sent one sheet at a time or several sheets at a time, a coating device **60**, a cover sheet storing section **80** that stores the cover sheets S**2**, a cover sheet supporting section **90** that supports the cover sheet S**2**, and a booklet ejection section **100**.

The sheet S**1** discharged from the image forming apparatus A either is discharged to the ejection tray **20** via the ejection path **12** or is conveyed to the sheet reversing section **40** by the switching gate **11** provided in the conveying section **10**. If the mode of operation is not the bookbinding mode, the sheets S**1** are discharged to the ejection tray **20**.

In the bookbinding mode, the sheets S**1** are conveyed to the sheet reversing section **40** via the conveying path **13**, and, after being switched back in the sheet reversing section **40**, they are conveyed to the stacking section **50**. In the stacking section **50**, the sheets S**1** are stacked until the number of sheets becomes equal to a set number, the stacking section **50** is rotated when the number of sheets stacked becomes equal to the set number, and the stack of sheets S**1** is held in an almost vertical condition.

Adhesive is coated by the coating device **60** on the bottom surface of the stack of sheets S**1** held in the vertical condition by the stacking section **50**.

A cover S2 is contacted with and adhered to the stack of sheets S1 on which adhesive has been coated.

The booklet S3 prepared by adhering the cover sheet S2 to the stack of sheets S1 is discharged to the booklet ejection section **100**.

FIG. **3** is a diagram showing the coating process.

The coating device **60** is placed below the sheet stack SS of the sheets S1, and during its forward movement driven by the motor MT1 indicated by the arrow W2, the coating roller **602** coats the adhesive AD on the spine SA of the sheet stack SS, and during the reverse movement indicated by the arrow W3, the coating roller **602** coats the adhesive AD on the spine SA.

The home position of the coating device **60** is the left end position in FIG. **3**, which is located at the deep side of the bookbinding apparatus shown in FIG. **2**, and at this home position, pellets PT of the adhesive are replenished from the replenishment device **61**. The coating roller **602** is rotated in the direction indicated by the arrow W1 due to the drive of the motor MT2 during the forward and reverse movements thereby scooping up the adhesive from the adhesive reservoir **601**, and coats it on the spine SA of the sheet stack SS.

FIG. **4** is a diagram showing the configuration of the coating device **60**.

The coating device **60** has an adhesive reservoir **601** that stores the adhesive AD, a coating roller **602**, two regulating members **603** and **604**, a heater **605**, and an adhesive quantity sensor **606**.

Although the pellets inside the adhesive reservoir **601** are heated and melted by the heater **605** thereby forming the coating liquid of the adhesive AD, the quantity of the adhesive AD is detected by the adhesive quantity sensor **606** made up of a temperature sensor, and the liquid level is maintained constant. The part **603** is a regulating member having the shape of a rod with an almost circular cross-section, and the regulating member **604** is supported by a supporting member **607** having the shape of a plate, and limits the thickness of the layer of adhesive above the coating roller **602** using its bottom edge **604**B, and restricts the thickness of the adhesive layer on the spine SA of the sheet stack SS using its top edge **604**A.

The adhesive reservoir **601** is set by rotating from the standby state indicated by dotted lines to the coating state indicated by continuous lines around the shaft **601**A.

The adhesive quantity sensor **606** has a temperature detecting device such as a thermistor, the detected temperature is high when the adhesive quantity sensor **606** is immersed in the liquid of the adhesive AD, and the detected temperature drops when the liquid level goes down and the adhesive quantity sensor **606** gets separated from the liquid level. The fact that the adhesive quantity has fallen below a prescribed value is detected by detecting this drop in the temperature.

The replenishment of the adhesive is carried out when the adhesive quantity drop detection signal is output.

The replenishment device **61** is explained here referring to FIG. **5** to FIG. **8**.

FIG. **5** is a cross-sectional view diagram of the replenishing device **61**, FIG. **6** shows the important parts of the replenishing device **61** before the operations are started, and FIG. **7** shows the important parts of the replenishing device **61** during replenishment. FIG. **8** shows the drive system in the replenishing device **61**.

The replenishment device **61** is made up of a hopper **62** as the pellet storing section that stores the pellets PT of the adhesive and a replenishing pipe **63** through which the pellets PT drop down, and the frame **62**A constituting the hopper **62** supports the different parts described below.

The replenishing device **61** is incorporated into the bookbinding apparatus B in the condition shown in FIG. **5**, that is, in the condition in which the hopper **62** and the replenishing pipe **63** are inclined downward towards the left, and the pellets PT drop along the bottom surface of the frame **62**A and the bottom surface of the replenishing pipe **63**, and are supplied to the coating device **60**.

The belt **663** that conveys the pellets PT is entrained about the rollers **664**, **666**, **667**, **669** and **673** in the lower part of the hopper **62**. The roller **666** is the drive roller and rotates in the anti-clockwise direction by being driven by the motor MT**3** which is a constituent part of the replenishing member.

The belt **663** which is a constituent part of the replenishing member has undulations formed on its outer peripheral surface as is shown in the enlarge view diagram of FIG. **5**A, and because of this undulating surface, not only the pellets are conveyed definitely, but also the area of contact with the pellets PT is made small thereby preventing adhesion between the pellets PT and the belt **663**. Because four pressure rollers **670** press the belt **663** against the frame **62**A using the force of springs, the spacing between the frame **62**A and the belt **663** is restricted so that it does not become larger than a prescribed limiting value, and because of this, the amount of conveying of the pellets PT by the belt **663** is controlled to be almost constant.

The rollers **664** and **666** are supported by the supporting plate **662** that can swing centering on the rotating shaft **666**A of the roller **666**, and the supporting plate **662** is pulled in the clockwise direction by a pulling type spring **665**. Because of this, a constant tension force is applied to the belt **663** by the roller **664** pulled by the spring **665**.

The replenishing device **61** in the stopped state before starting operations is as shown in FIG. **6**, and in this state, the roller **669** has narrowed the pellet discharge outlet, and the pellets PT stay in the hopper **62** being blocked by the belt **663** supported by the roller **669** as shown in FIG. **6**.

When the replenishing device **61** starts operating, the roller **669** moves to the left as shown in FIG. **7**, the belt **663** recedes, thereby making wide the pellet discharge outlet of the hopper **62**. Because of this, the pellets PT drop up to the discharge outlet, and the pellets PT that have dropped fall along the bottom surface of the frame **62**A due to the conveying action of the belt **663**.

During the period when the replenishing device is carrying out replenishing operation, the roller **669** reciprocates between the position shown in FIG. **6** and the position shown in FIG. **7**, and because of this reciprocating operation, the pellets PT drop in small quantities at a controlled rate and are supplied to the coating device **60**.

The drive mechanism that makes the roller **669** carry out reciprocating movement is explained using FIG. **8**.

A support plate **675** that rotates integrally with the roller **666** has been fixed to the shaft **666**A of the roller **666**, and a link **676** has been supported in a rotatable manner to the pin **677** provided at one end of the supporting plate **675**.

The shaft **669**A of the roller **669** engages with and enters into the long hole **676**A provided in the link **676**.

The shaft **669**A of the roller **669** is pulled to the right in FIG. **8**(*a*) by a pulling type spring **668**. Therefore, the roller **669** is maintained at the prescribed position by the tension force of the belt **663** and the force of the spring **668**.

Although the supporting plate **675** rotates due to the rotation of the roller **666**, because of the rotation of the supporting plate **675**, the right end position of the link **676** moves in the left and right directions in FIG. **7**, and because of this movement, the position of the roller **669** moves in the left and right directions, and hence the pellet discharge outlet of the hopper **62** contracts and expands as is shown in the state in FIG. **6** and the state in FIG. **7**.

This contraction and expansion are repeated during the replenishment operation, and the pellets PT are supplied to the coating device **60** in small quantities at a controlled rate.

Returning to FIG. **5**, FS is a replenishment sensor that detects the pellets PT falling from the hopper **62**, and is made of a light emitting device FS**1** and a light receiving device FS**2**. The number of pellets PT supplied to the coating device **60** is detected by the replenishment sensor FS. The count of the number of pellets PT by the replenishment sensor FS is proportional to the number of pellets PT replenished.

As has been explained above, while a drop in the liquid level of the adhesive AD is detected, and replenishment of the pellets PT of the adhesive is carried out based on the detection signal, the rate of replenishment of the pellets PT is explained here using FIG. **9**. FIG. **9** is a diagram showing the rate of replenishment for carrying out appropriate adhesion for the number of sheets S**1** constituting the sheet stack SS.

In FIG. **9**, the horizontal axis denotes the number P of the sheets S**1** constituting the sheet stack SS, and the vertical axis denotes the count N of the replenishment sensor FS of the pellets PT that have been replenished, and the graph shows the results obtained by carrying out a coating experiment using a coating apparatus of FIG. **4**.

Further, although in FIG. **9** the horizontal axis is taken to indicate the number of sheets, theoretically, it is the quantity of adhesive consumed by coating, and the quantity of adhesive consumed corresponds, mainly, to the thickness of the sheet stack SS determined by the number of sheets and the thickness of each sheet, and to the sheet size. In addition, the quantity of adhesive consumed also changes depending on the type of sheet used, such as coated paper, non-coated paper, etc.

The straight line L**1** is expressed by the following equation.

$$\text{Appropriate rate } N = 10 + 0.019P \qquad \text{Equation 1}$$

However, the count of the replenishment sensor FS is not necessarily equal to the number of pellets replenished, and in the example of the experiment, one count of the replenishment sensor FS corresponded to 2.5 pellets.

Further, in the actual control, as is shown in the broken line L**2**, the number of pellets with the part below the decimal point being discarded is used as the appropriate replenishment quantity for the control. The controller (to be described later) receives the signal of detecting that the liquid level has fallen down from the adhesive quantity sensor **606** (shown in FIG. **4**), starts feeding the pellets, and stops the replenishment when the count value corresponding to the quantity of replenishment corresponding to the number of sheets given by Equation 1 reaches the appropriate value shown in FIG. **9**.

Because of this type of control, the liquid level LS of the adhesive is maintained at all times at almost a constant level, and uniform coating is done.

FIG. **10** is a block diagram of the control system that carries out replenishment control, and FIG. **11** is a flow chart of the replenishment control carried out by the controller CR.

The replenishment control of adhesive is explained in the following referring to FIG. **10** and FIG. **11**.

The controller CR acquires the information of the sheet stack SS from the main unit controller MC which is the control section of the image forming apparatus A, and, based on the liquid level low detection signal of the adhesive quantity sensor **606** that detects the liquid level in the adhesive reservoir, carries out the pellet replenishment control of starting the drive motor MT**3** which is a constituent part of the replenishment section that replenishes pellets to the adhesive reservoir thereby supplying the pellets PT, and stopping the motor MT**3** at the time when the replenishment quantity obtained from the replenishment quantity detection signal acquired from the replenishment sensor FS reached the appropriate value.

In STEP **1**, the information of the sheet stack SS to be coated with the adhesive is input. The information of the sheet stack can be the number of sheets constituting the booklet, the thickness of each sheet, the paper type indicating the differences such as coated paper, non-coated paper, etc., the sheet size, etc.

In STEP **2**, the coating device **60** makes a to-and-fro movement and the adhesive is coated on the spine of the sheet stack SS.

In STEP **3**, lowering in the liquid level of the adhesive is detected after carrying out the coating process in STEP **2**, and the operation is ended if no lowering is detected (N in STEP **3**), and if a lowering is detected (Y in STEP **3**), the appropriate coating quantity is calculated (STEP **4**).

The calculation in STEP **4** is made, for example, following the broken line L**2** in FIG. **9**, and referring to the lookup table stored in the storage section of the controller CR.

In STEP **5**, the replenishment of pellets is started.

In STEP **6**, the output of the replenishment sensor FS is monitored, and the replenishment is stopped (STEP **7**) at the instant of time when the count value of the replenishment sensor FS reaches the appropriate value (Y in STEP **6**).

The operations are ended when the set number of copies of the booklet has been formed and the bookbinding job is completed (Y in STEP **8**), or else, if the job is not ended, the operations return to STEP **2** (N in STEP **8**).

While in FIG. **10** and FIG. **11** the controller CR inputs the information of the sheet stack SS, and, based on that information, the pellet replenishment quantity is being determined, the information of the sheet stack SS, as has been described above, can be the number of sheets, the sheet thickness, the type of sheet, the sheet size, etc., apart from automatic replenishment of the controller CR calculating the rate of replenishment from these items of information, it is also possible for the operator to set directly the rate of replenishment.

For example, it is possible to provide the rate of replenishment in several steps and the operator selects and sets the appropriate rate of replenishment from among these steps based on the thickness of the sheet stack SS, etc., and the setting by the operator is input to the controller CR as information of the sheet stack SS.

In automatic replenishment control, while the controller CR acquires the information of the number of sheets, the sheet thickness, the sheet size, etc., from the image forming apparatus A and calculates the appropriate rate of replenishment, it is also possible to have a configuration in which a sheet thickness sensor to detect the thickness of the sheet stack is provided in the stacking section **50** of the sheet stack SS in FIG. **2**, and the controller CR calculates the appropriate rate of replenishment based on the detection signal from the sheet thickness sensor.

In the embodiment, since predictive control is being made of calculating the appropriate quantity of replenishment of adhesive based on the information of the stack of sheets constituting the booklet, and carrying out the replenishment, even in the case of a small size coating apparatus, it is possible to realize a bookbinding apparatus that prepares high quality booklets by carrying out uniform coating of the adhesive at all times, and maintaining high adhesion strength.

What is claimed is:

1. A bookbinding apparatus for forming a booklet by coating an adhesive on a spine of a stack of sheets, comprising:

a coating apparatus, having:

an adhesive reservoir for storing a liquid of the adhesive; and

a coating roller for coating on the spine of the stack of sheets the adhesive scooped up from the adhesive reservoir;

a pellet storage section for storing pellets of the adhesive;

a replenishing section for replenishing the pellets of the adhesive from the pellet storage section into the adhesive reservoir;

an adhesive quantity sensor for detecting a liquid level in the adhesive reservoir; and

a controller for controlling the replenishing section based on a detection signal of the adhesive quantity sensor,

wherein the controller calculates a rate of replenishing the pellets based on information of the stack of sheets, the information comprising a number of sheets included in the stack of sheets, and

wherein the controller controls the rate of replenishing the pellets by controlling the replenishing section based on the calculated rate of replenishing the pellets.

2. The bookbinding apparatus of claim **1**, wherein the information of the stack of sheets further comprises at least one piece of information of a thickness of a sheet in the stack of sheets, a type of the sheet, and a size of the sheet.

3. The bookbinding apparatus of claim **1**, further comprising:

a replenishment sensor for detecting an amount of the pellets to be replenished by the replenishing section,

wherein the controller controls the replenishing section based on a signal from the replenishment sensor.

4. A bookbinding system, comprising:

an image forming apparatus for forming images on sheets; and

a bookbinding apparatus for forming a booklet by coating an adhesive on a spine of a stack of sheets received from the image forming apparatus, the book binding apparatus comprising:

a coating apparatus, having:

an adhesive reservoir for storing a liquid of the adhesive; and

a coating roller for coating on the spine of the stack of sheets the adhesive scooped up from the adhesive reservoir;

a pellet storage section for storing pellets of the adhesive;

a replenishing section for replenishing the pellets of the adhesive from the pellet storage section into the adhesive reservoir;

an adhesive quantity sensor for detecting a liquid level in the adhesive reservoir; and

a controller for controlling the replenishing section based on a detection signal of the adhesive quantity sensor,

wherein the controller calculates a rate of replenishing the pellets based on information of the stack of sheets, the information comprising a number of sheets included in the stack of sheets, and

wherein the controller controls the rate of replenishing the pellets by controlling the replenishing section based on the calculated rate of replenishing the pellets.

5. An adhesive coating method for coating an adhesive on a spine of a stack of sheets by moving a coating apparatus relative to the stack of sheets along the spine of the stack of sheets, the coating apparatus having an adhesive reservoir for storing a liquid of the adhesive and a coating roller for coating the adhesive scooped up from an adhesive reservoir, the adhesive coating method comprising:

detecting a liquid level of the adhesive in the adhesive reservoir by an adhesive quantity sensor;

calculating a rate of replenishing the pellets based on information of the stack of sheets, the information comprising a number of sheets included in the stack of sheets; and

activating, based on the calculated rate of replenishing the pellets, a replenishing section to replenish the pellets of the adhesive from a pellet storage section into the adhesive reservoir, when lowering of the liquid level is detected by the adhesive quantity sensor.

6. An adhesive coating method of claim **5**, wherein the rate of replenishing the pellets is changed based on instructions from a user.

7. An adhesive coating method of claim **6**, wherein the rate of replenishing the pellets is changed based on information of the stack of sheets.

8. The adhesive coating method of claim **5**, wherein the information of the stack of sheets further comprises at least one piece of information of a thickness of a sheet in the stack of sheets, a type of the sheet, and a size of the sheet.

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